

GENETICS (GENE)

GENE 104Q. Law and the Biosciences. 3 Units.

Preference to sophomores. Focus is on human genetics; also assisted reproduction and neuroscience. Topics include forensic use of DNA, genetic testing, genetic discrimination, eugenics, cloning, pre-implantation genetic diagnosis, neuroscientific methods of lie detection, and genetic or neuroscience enhancement. Student presentations on research paper conclusions.

GENE 199. Undergraduate Research. 1-18 Unit.

Students undertake investigations sponsored by individual faculty members. Prerequisite: consent of instructor.

GENE 200. Genetics and Developmental Biology Training Camp. 1 Unit.

Open to first year Department of Genetics and Developmental Biology students, to others with consent of instructors. Introduction to basic manipulations, both experimental and conceptual, in genetics and developmental biology.

Same as: DBIO 200

GENE 202. Human Genetics. 4 Units.

Utilizes lectures and small group activities to develop a working knowledge of human genetics as applicable to clinical medicine. Basic principles of inheritance, risk assessment, and population genetics are illustrated using examples drawn from diverse areas of medical genetics practice including prenatal, pediatric, adult and cancer genetics. Practical aspects of molecular and cytogenetic diagnostic methods are emphasized.

Existing and emerging treatment strategies for single gene disorders are also covered. Prerequisites: basic genetics. Only available to MD and MOM students.

GENE 205. Advanced Genetics. 3 Units.

For PhD students in any of the Biosciences Departments and Programs at Stanford University. Emphasis on developing the ability to solve problems using genetic ideas and methods, to understand the nature and reliability of genetic inference, and to apply genetic reasoning to biological research. Weekly paper discussions based on original research papers that define or illustrate the ideas and techniques covered in the lecture.

GENE 207. Microfluidic Device Laboratory. 3-4 Units.

This course exposes students to the design, fabrication, and testing of microfluidic devices for biological applications through combination of lectures and hands-on lab sessions. In teams of two, students will produce a working prototype devices designed to address specific design challenges within the biological community using photolithography, soft lithography, and imaging techniques.

Same as: BIOE 301D

GENE 208. Gut Microbiota in Health and Disease. 3 Units.

Preference to graduate students. Focus is on the human gut microbiota. Students will receive instruction on computational approaches to analyze microbiome data and must complete a related project.

Same as: BIOE 221G, MI 221

GENE 210. Genomics and Personalized Medicine. 3 Units.

Principles of genetics underlying associations between genetic variants and disease susceptibility and drug response. Topics include: genetic and environmental risk factors for complex genetic disorders; design and interpretation of genome-wide association studies; pharmacogenetics; full genome sequencing for disease gene discovery; population structure and genetic ancestry; use of personal genetic information in clinical medicine; ethical, legal, and social issues with personal genetic testing. Hands-on workshop making use of personal or publicly available genetic data. Prerequisite: GENE 202, Gene 205 or BIOS 200.

Same as: DBIO 220

GENE 211. Genomics. 3 Units.

The goal of this course is to explore different genomic approaches and technologies, to learn how they work from a molecular biology view point, and to understand how they can be applied to understanding biological systems. In addition, we teach material on how the data generated from these approaches can be analyzed, from an algorithmic perspective. The papers that are discussed are a mixture of algorithmic papers, and technological papers. Finally, the course has a strong programming component, with Python being the language that we teach. All of our problem sets require Python programming - while beginning programmers succeed in our course, it is a steep learning curve, and the problem sets can require a significant time investment. Basic Python knowledge is required.

GENE 212. Introduction to Biomedical Informatics Research Methodology. 3-5 Units.

Capstone Biomedical Informatics (BMI) experience. Hands-on software building. Student teams conceive, design, specify, implement, evaluate, and report on a software project in the domain of biomedicine. Creating written proposals, peer review, providing status reports, and preparing final reports. Issues related to research reproducibility. Guest lectures from professional biomedical informatics systems builders on issues related to the process of project management. Software engineering basics. Because the team projects start in the first week of class, attendance that week is strongly recommended. Prerequisites: BIOMEDIN 210 or 214 or 215 or 217 or 260. Preference to BMI graduate students. Consent of instructor required.

Same as: BIOE 212, BIOMEDIN 212, CS 272

GENE 214. Representations and Algorithms for Computational Molecular Biology. 3-4 Units.

Topics: introduction to bioinformatics and computational biology, algorithms for alignment of biological sequences and structures, computing with strings, phylogenetic tree construction, hidden Markov models, basic structural computations on proteins, protein structure prediction, protein threading techniques, homology modeling, molecular dynamics and energy minimization, statistical analysis of 3D biological data, integration of data sources, knowledge representation and controlled terminologies for molecular biology, microarray analysis, machine learning (clustering and classification), and natural language text processing. Prerequisite: CS 106B; recommended: CS161; consent of instructor for 3 units.

Same as: BIOE 214, BIOMEDIN 214, CS 274

GENE 215. Frontiers in Biological Research. 1 Unit.

Students analyze cutting edge science, develop a logical framework for evaluating evidence and models, and enhance their ability to design original research through exposure to experimental tools and strategies. The class runs in parallel with the Frontiers in Biological Research seminar series. Students and faculty meet on the Tuesday preceding each seminar to discuss a landmark paper in the speaker's field of research. Following the Wednesday seminar, students meet briefly with the speaker for a free-range discussion which can include insights into the speakers' paths into science and how they pick scientific problems.

Same as: BIOC 215, DBIO 215

GENE 216. Practical Considerations and Industry Perspective on Academic-Industry Collaborations. 1 Unit.

Provides an overview, fundamentals and practical considerations for different aspects of academic-industry collaborations by inviting current industrial experts to share their views and to answer questions. The different aspects include collaboration models, proposal building, IP right sharing, funding opportunities, sabbatical and internship in industry, industry job searching, etc. This class also serves as a platform to connect with Bay Area biotech and pharmaceutical executives and experts.

GENE 217. Translational Bioinformatics. 3-4 Units.

Computational methods for the translation of biomedical data into diagnostic, prognostic, and therapeutic applications in medicine. Topics: multi-scale omics data generation and analysis, utility and limitations of public biomedical resources, machine learning and data mining, issues and opportunities in drug discovery, and mobile/digital health solutions. Case studies and course project. Prerequisites: programming ability at the level of CS 106A and familiarity with biology and statistics.

Same as: BIOE 217, BIOMEDIN 217, CS 275

GENE 218. Computational Analysis of Biological Information: Introduction to Python for Biologists. 2 Units.

Computational tools for processing, interpretation, communication, and archiving of biological information. Emphasis is on sequence and digital microscopy/image analysis. Intended for biological and clinical trainees without substantial programming experience.

Same as: MI 218, PATH 218

GENE 219. Current Issues in Genetics. 1 Unit.

Current Issues in Genetics is an in-house seminar series that meets each Academic Quarter for one hour per week (Friday, 4:00-5:00) and features talks by Genetics Department faculty, students, and postdoctoral fellows (with occasional visiting speakers from other Stanford departments).

Thus, over the Academic Year, it provides a comprehensive overview of the work going on in the Department. Student attendance at the seminars will be required, with short written assignments (typically three per Quarter) to encourage thinking about the material presented in the talks.

GENE 221. Current Issues in Aging. 2 Units.

Current research literature on genetic mechanisms of aging in animals and human beings. Topics include: mitochondria mutations, insulin-like signaling, sirtuins, aging in flies and worms, stem cells, human progeria, and centenarian studies. Prerequisite: GENE 203, 205 or BIOS 200.

GENE 222. Cloud Computing for Biology and Healthcare. 3 Units.

Big Data is radically transforming healthcare. To provide real-time personalized healthcare, we need hardware and software solutions that can efficiently store and process large-scale biomedical datasets. In this class, students will learn the concepts of cloud computing and parallel systems' architecture. This class prepares students to understand how to design parallel programs for computationally intensive medical applications and how to run these applications on computing frameworks such as Cloud Computing and High Performance Computing (HPC) systems. Prerequisites: familiarity with programming in Python and R.

Same as: BIOMEDIN 222, CS 273C

GENE 223. Aging: Science and Technology for Longevity. 2-3 Units.

Is aging another disease that can be ultimately cured? We will look at the biology of aging, transitioning from the molecular level through to the cellular and systems level. What are age-related diseases, can lifespan be extended and are centenarians different? Additionally how can artificial intelligence create robotic and software assistants as we get older and is living forever possible in any form? Topics will include: molecular theories of aging, impact of oxidative stress, age-related diseases, artificial intelligence for longevity, and innovations to improve the quality of life as we age.

GENE 224. Principles of Pharmacogenomics. 3 Units.

This course is an introduction to pharmacogenomics, including the relevant pharmacology, genomics, experimental methods (sequencing, expression, genotyping), data analysis methods and bioinformatics. The course reviews key gene classes (e.g., cytochromes, transporters) and key drugs (e.g., warfarin, clopidogrel, statins, cancer drugs) in the field. Resources for pharmacogenomics (e.g., PharmGKB, Drugbank, NCBI resources) are reviewed, as well as issues implementing pharmacogenomics testing in the clinical setting. Reading of key papers, including student presentations of this work; problem sets; final project selected with approval of instructor. Prerequisites: two of BIO 41, 42, 43, 44X, 44Y or consent of instructor.

Same as: BIOMEDIN 224

GENE 230. Genetic Epidemiology. 3 Units.

This course presents fundamental concepts and methods in genetic epidemiology, with examples on genetic studies of chronic diseases, including cancer, cardiovascular disease, metabolic conditions, and autoimmune diseases. It will provide an overview of various study designs, including family studies, and it covers fundamental analyses, inferences, and their strengths and limitations. It will include topics such as assessing genetic influences on disease; advances in genomics technology; family based study designs for linkage, exome sequencing and case-parent trios; candidate gene and genome-wide association studies of both common and rare genetic variants; gene-environment interactions, epistasis and non-Mendelian genetics; software and web-based data resources; ethical issues in genetic epidemiology; and applications of genetic epidemiology to clinical practice and public health. Guest speakers will discuss these concepts through the lens of various chronic diseases. Prerequisite: introductory biostatistics or epidemiology, biology, and genetics. Biostatistics (intro) or epidemiology (intro), biology, genetics (intro).

Same as: EPI 224

GENE 232. Advanced Imaging Lab in Biophysics. 4 Units.

Laboratory and lectures. Advanced microscopy and imaging, emphasizing hands-on experience with state-of-the-art techniques. Students construct and operate working apparatus. Topics include microscope optics, Koehler illumination, contrast-generating mechanisms (bright/dark field, fluorescence, phase contrast, differential interference contrast), and resolution limits. Laboratory topics vary by year, but include single-molecule fluorescence, fluorescence resonance energy transfer, confocal microscopy, two-photon microscopy, microendoscopy, and optical trapping. Limited enrollment. Recommended: basic physics, basic cell biology, and consent of instructor.

Same as: APPPHYS 232, BIO 132, BIO 232, BIOPHYS 232

GENE 235. C. Elegans Genetics. 2 Units.

Genetic approaches to *C. elegans*, practice in designing experiments and demonstrations of its growth and anatomy. Probable topics include: growth and genetics, genome map and sequence, mutant screens that start with a desired phenotype, reverse genetics and RNAi screens, genetic duplications, uses of null phenotype non-null alleles, genetic interactions and pathway analysis, and embryogenesis and cell lineage. Focus of action, mosaic analysis, and interface with embryological and evolutionary approaches.

GENE 236. Deep Learning in Genomics and Biomedicine. 3 Units.

Recent breakthroughs in high-throughput genomic and biomedical data are transforming biological sciences into "big data" disciplines. In parallel, progress in deep neural networks are revolutionizing fields such as image recognition, natural language processing and, more broadly, AI. This course explores the exciting intersection between these two advances. The course will start with an introduction to deep learning and overview the relevant background in genomics and high-throughput biotechnology, focusing on the available data and their relevance. It will then cover the ongoing developments in deep learning (supervised, unsupervised and generative models) with the focus on the applications of these methods to biomedical data, which are beginning to produced dramatic results. In addition to predictive modeling, the course emphasizes how to visualize and extract interpretable, biological insights from such models. Recent papers from the literature will be presented and discussed. Students will be introduced to and work with popular deep learning software frameworks. Students will work in groups on a final class project using real world datasets. Prerequisites: College calculus, linear algebra, basic probability and statistics such as CS 109, and basic machine learning such as CS 229. No prior knowledge of genomics is necessary.

Same as: BIODS 237, BIOMEDIN 273B, CS 273B

GENE 242. Genetics of Viral Emergence and Emerging Viruses. 2 Units.

This course will cover genetic and complementary approaches toward understanding and mitigating the emergence of new viral epidemics. Topics are: I. Viral Emergence ('Viral life in prebiotic soup', 'emergence in cellular contexts', 'viruses from viruses', 'viruses and their non-viral cousins'), II. Emergent Virology ('tracking the virome', 'genomics of recent viral pandemics', and 'the spectrum of viral malevolence'), and III. The Virome Interface ('environmental influences on viral epidemics', 'viruses, genes, and human behavior', 'big data in the service of controlling epidemics', and 'genetic approaches to viral treatment').

GENE 247. Genomic approaches to the study of human disease. 3 Units.

This course will cover a range of genetic and genomic approaches to studying human phenotypic variation and disease. We will discuss the genetic basis of Mendelian and complex diseases, as well as clinical applications including prenatal testing, and pediatric and cancer diagnostics. The course will include lectures as well as critical reading and discussion of the primary literature. Prerequisite: BIO 82 or equivalent. Open to advanced undergraduate students. Same as: BIO 247

GENE 260. Supervised Study. 1-18 Unit.

Genetics graduate student lab research from first quarter to filing of candidacy. Prerequisite: consent of instructor.

GENE 267. Molecular Mechanisms of Neurodegenerative Disease. 4 Units.

The epidemic of neurodegenerative disorders such as Alzheimer's and Parkinson's disease occasioned by an aging human population. Genetic, molecular, and cellular mechanisms. Clinical aspects through case presentations. This class is open to both graduate and undergraduate students, but requires sufficient backgrounds in college level genetics, cell biology and biochemistry. Undergraduates who are interested are required to contact the course director first.

Same as: BIO 267, NENS 267

GENE 268. Biology and Applications of CRISPR/Cas9: Genome Editing and Epigenome Modifications. 1 Unit.

This course is designed to provide a broad overview of the biology and applications of the revolutionary CRISPR/Cas9 system, with detailed exploration of several areas: / / --Basic biology of the CRISPR/Cas9 system / --High-throughput screening using CRISPR/Cas9 / --Epigenetic modifications and transcriptional regulation using dCas9 / --Therapeutic applications of gene editing with CRISPR / --Disease modeling with CRISPR / --Ethical considerations of the use of CRISPR/Cas9 / / The course will be geared toward advanced undergraduates and graduate students, and will assume a basic background in molecular biology and genetics. The course will be lecture-based, with frequent opportunities for discussion and questions.

Same as: BIOS 268

GENE 271. Human Molecular Genetics. 3 Units.

For genetic counseling students, graduate students in genetics, medical students, residents, and postdoctoral fellows interested in the practice of medical genetics and genomics. Gene structure and function; the impact of mutation and polymorphism as they relate to developmental pathways and human disease; mitochondrial genetics; approaches to the study of complex genetic conditions; GWAS and genome sequencing technologies; variant interpretation; gene therapy, stem cell biology, and pharmacogenetics. Undergraduates require consent of instructor and a basic genetics course. Non-GC students: Please contact the instructor when you enroll.

Same as: CHPR 271

GENE 272. Introduction to Medical Genetics. 2-3 Units.

For genetic counseling students, graduate students in human genetics, medical students, residents, and fellows; undergraduates with consent of instructor. Principles of medical genetics practice, including taking a family history, modes of inheritance and risk assessment, and mathematical principles of medical genetics (Bayes theorem, population genetics). An additional problem set is required for 3 units.

Same as: CHPR 272

GENE 273. Introduction to Clinical Genetics Testing. 2 Units.

For genetic counseling students, medical students, residents, and fellows. Uses a combination of case based assignments, laboratory observation and didactic lectures to introduce techniques and technology used in cytogenetics, molecular genetics and biochemical genetic testing, and to introduce clinical features of common genetic conditions that are commonly diagnosed through genetic testing. Non-GC students: Please contact the instructor when you enroll.

GENE 274A. A Case Based Approach to Clinical Genetics. 2 Units.

For genetic counseling students and medical genetics residents and fellows. Case-based scenarios and guest expert lectures. Students learn skills in case preparation, management, and presentation, as well as content around common genetic disorders.

Same as: CHPR 274A

GENE 274B. A Case Based Approach to Clinical Genetics. 2 Units.

For genetic counseling students and medical genetics residents and fellows. Case-based scenarios and guest expert lectures. Students learn skills in case preparation, management, and presentation, as well as content around common genetic disorders. This course is a continuation of GENE 274A, but may be taken individually with instructor permission.

Same as: CHPR 274B

GENE 275. Role Play and Genetic Counseling Observations. 2 Units.

For genetic counseling students only. Students role play aspects of genetic counseling sessions and learn through clinical observations and personal reflection. Observation includes genetic counseling sessions in prenatal, pediatric, and specialty settings.

GENE 276. Genetic Counseling Fieldwork. 1-7 Unit.

For genetic counseling students only. Supervised clinical experiences. May be repeated for credit. Prerequisite: GENE 275.

GENE 278. Prenatal Genetic Counseling. 1 Unit.

Online course for genetic counseling students, graduate students in genetics, medical students, residents, fellows, and nurses interested in prenatal genetics. Genetic counseling students should take this course in conjunction with their initial prenatal genetics rotation. Topics include: prenatal screening and diagnostic testing, ultrasound, genetic carrier screening, teratology, fetal treatment and intervention, perinatal loss, termination, and infertility. Non-GC students: Please contact the instructor when you enroll.

Same as: CHPR 278

GENE 279. Pediatric and Adult Genetic Counseling. 1 Unit.

Internet based course for genetic counseling students, graduate students in genetics, medical students, residents, and fellows; genetic counseling students should take this course in conjunction with their initial general genetics rotation. Topics include: clinical reasoning in medical genetics, techniques to prepare for the medical genetics visit, assessment of child development and medical history in the context of a genetic workup, dysmorphology, development of a differential diagnosis, and resources for case management and family support. Non-GC students: Please contact the instructor when you enroll.

Same as: CHPR 279

GENE 280. Metabolic Genetic Counseling. 1 Unit.

Internet based course for genetic counseling students, graduate students in genetics, medical students, residents, and fellows. Genetic counseling students should take this course in conjunction with their metabolic genetics rotation. Topics include: overview of metabolic diseases; common pathways; diagnosis, management, and treatment of metabolic disorders; and newborn screening. Non-GC students: Please contact the instructor when you enroll.

Same as: CHPR 280

GENE 281. Cancer Genetic Counseling. 1 Unit.

Internet based course for genetic counseling students, graduate students in genetics, medical students, residents, and fellows; genetic counseling students should take this course in conjunction with their initial cancer genetics rotation. Topics include: cancer biology and cytogenetics; diagnosis and management of common cancer genetic syndromes; predictive testing; psychology of cancer genetic counseling; and topics recommended by ASCO guidelines. Non-GC students: Please contact the instructor when you enroll.

Same as: CHPR 281

GENE 282A. Genetic Counseling Research Seminar. 1 Unit.

For genetic counseling students only. Facilitated discussions on identifying a topic and mentor for genetic counseling departmental research projects.

GENE 282B. Genetic Counseling Research Seminar. 1 Unit.

For genetic counseling students only. Lectures and facilitated discussions on research methodology for genetic counseling departmental research projects. Prerequisite: GENE 282A.

GENE 283. Genetic Counseling Research. 1-8 Unit.

Genetic counseling students conduct clinical research projects as required by the department for graduation. May be repeated for credit. Pre- or corequisite: GENE 282.

GENE 284. Medical Genetics Seminar. 1 Unit.

Presentation of clinical and research topics in human genetics, followed by case presentations from the medical genetics and biochemical genetics services. Course may be completed online or in-person. Non-GC students: Please contact the instructor when you enroll.

Same as: CHPR 284

GENE 285A. Genetic Counseling Seminar. 3 Units.

Year-long seminar primarily for genetic counseling students. Fall: An introduction to genetic counseling principles, techniques, and professional development.

GENE 285B. Genetics Counseling Seminar. 3 Units.

Year-long seminar primarily for genetic counseling students. Winter: The impact of chronic illness and genetic disease across the lifespan.

GENE 285C. Genetic Counseling Seminar. 3 Units.

Year-long seminar primarily for genetic counseling students. Spring: The application of counseling theories, models, and therapy to the practice of genetic counseling.

GENE 286. Advanced Genetic Counseling Seminar. 2 Units.

For genetic counseling students only. This course will enhance students' advanced counseling skills through formal case presentations, observations of community resources, and a variety of presentations on professional issues. Must be taken for 3 quarters. Prerequisites: GENE 285 A,B,C and 276.

GENE 287. CARDIOVASCULAR GENETICS. 1 Unit.

Online course for genetic counseling students, graduate students in genetics, medical students, residents, fellows, and nurses interested in inherited cardiovascular conditions. Genetic counseling students should take this course in conjunction with their cardiovascular genetics rotation. Topics include: Basic cardiology principles, including relevant anatomy and physiology; diagnosis, management and genetic testing as it relates to common inherited cardiovascular conditions in both the pediatric and adult setting; predictive genetic testing issues specific to inherited cardiovascular conditions; psychological issues related to sudden death conditions. Non-GC students: Please contact the instructor when you enroll.

Same as: CHPR 287

GENE 288. Neurogenetics. 1 Unit.

Internet-based course for genetic counseling students, graduate students in genetics, medical students, residents, and fellow; genetic counseling students should take this course in conjunction with their neurogenetics rotation. Topics include: introduction to neurology for beginners, including an overview of neurologic exam and localization, to provide non-neurologist trainees a foundation for understanding the differential diagnosis process in neurology; common and exemplary neurogenetics disorders spanning the adult and pediatric neurologic sub-specialties; key genetic concepts such as triple repeat disorders and FSHD; ethical and psychological topics as well as gene-targets therapeutics. Medical students and graduate students outside of genetic counseling should obtain permission from instructor prior to enrollment. No prerequisite for genetic counseling students, genetics or neurology residents/fellows or post-docs. Non-GC students: Please contact the instructor when you enroll.

GENE 289. Variant Interpretation. 1 Unit.

Internet-based course for genetic counseling students, graduate students in genetics or bioscience, medical students, residents, and fellows. Genetic counseling students should take this course in conjunction with their variant interpretation rotation. Topics include a review of the types of genetic variants, HGVS nomenclature and standards, and technical aspects of variant calling, filtering, and prioritization. Attendees will become familiar with the types of evidence to support or refute pathogenicity and the standards in doing so, and will develop skills to critically assess the literature and existing databases for variant classification. Non GC-students: Please contact the instructor once you enroll.

GENE 299. Directed Reading in Genetics. 1-18 Unit.

Prerequisite: consent of instructor.

GENE 346. Advanced Seminar in Microbial Molecular Biology. 1 Unit.

Enrollment limited to PhD students associated with departmental research groups in genetics or molecular biology.

Same as: BIO 346, CSB 346

GENE 399. Graduate Research. 1-18 Unit.

Investigations sponsored by individual faculty members. Prerequisite: consent of instructor.

GENE 801. TGR Project. 0 Units.

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GENE 802. TGR Dissertation. 0 Units.

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